

# Imaging and Reports Journal

## Diagnosing Increased Intracranial Pressure by Measuring Optic Nerve Sheath Diameter

Hector R Diaz Aguila<sup>1</sup>  
Orlando Valdes Suarez<sup>2</sup>  
Anselmo Abdo Cuza<sup>3</sup>

<sup>1</sup>Intensive Care Unit, University Hospital of Sagua la Grande, Villa Clara, Cuba

<sup>2</sup>Polivalent Intensive Care Unit, University Hospital of San Antonio de los Baños, Artemisa Cuba

<sup>3</sup>Intensive Care Unit, Centro de Investigaciones Medico Quirurgicas CIMEQ, Havana, Cuba

### Abstract

**Introduction:** Optic nerve sheath diameter ultrasound is a rapid point of care tool for diagnosing and monitoring increased intracranial pressure.

**Development:** We described some important issues regarding this statement: brief anatomical description of optic nerve; measuring and finally the learning curve.

**Conclusion:** Measuring optic nerve sheath diameter using ultrasonography makes available a highly useful method to determine high intracranial pressure in clinical practice.

### Keywords

Point of care ultrasound; Optic nerve ultrasound; Optic nerve sheath diameter; High intracranial pressure

### Introduction

Point of Care Ultrasound (POCUS) has been developed since the late 1900s. Nowadays, it's an essential tool in medical care because of its benefits. It is performed at patient's bedside by the attending doctor and ensures, immediate results, reproducibility, patient safety and satisfaction, and low costs [1].

POCUS answers specific questions regarding structural or functional disorders of organs and systems:

- Does the patient have a pneumothorax ?
- What is the cause of dyspnoea ?
- How is the global systolic function of the heart ?
- Is there any evidence of deep venous thrombosis ?
- Does the patient have intra-abdominal free fluid ?
- Is high Intracranial Pressure (ICP) present ?

It's also safe for being used along with ultrasound to perform invasive and other procedures.

Elevated intracranial pressure is seen in head trauma, hydrocephalus, intracranial haemorrhage, sub-arachnoid haemorrhage from ruptured brain aneurysm, intracranial tumours, hepatic encephalopathy, and cerebral oedema.

Intractable elevated ICP can lead to death or devastating neurological damage either by reducing Cerebral Perfusion Pressure (CPP) and causing cerebral ischemia or by compressing and causing herniation of the brainstem or other vital structures. Prompt recognition is crucial in order to intervene appropriately [2].

Diagnosis of high ICP is made by various methods including insertion of intraventricular or intraparenchymal fiberoptic catheters (invasive methods) or by ultrasound measuring the optic nerve sheath.

ICP is the most common "terminal event" leading to death in neurosurgical patients and it must be treated immediately by the following measures depending of the patient's status: maintaining of the patent airways; maintaining an adequate blood pressure to ensure a cerebral perfusion can be quite challenging in the context of increasing ICP; use of controlled hyperventilation for lowers the partial pressure of CO<sub>2</sub> in arterial blood (PaCO<sub>2</sub>) and increases the pH in order to minimize vasodilation of cerebral blood vessels; administration of osmotic or other diuretics and finally surgical decompression [3].

Measuring ICP is of vital importance in clinical and neurocritical settings. Point of care ultrasound is a bedside imaging tool that is more and more accessible in most clinical, emergency and critical care departments.

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### \*Corresponding author:

**Prof. Hector Diaz Aguila**  
Intensive Care Unit  
University Hospital of Sagua la Grande  
Villa Clara, Cuba  
Tel: +55 47 999688078  
E-mail: hector Diaz@infomed.sld.cu

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## Development

The optic nerve sheath is contiguous with the dura mater, and the cerebrospinal fluid contained in it is contiguous to the subarachnoid space surrounding the brain and the spinal cord. As such, high ICP can be sonographically estimated by increasing Optic Nerve Sheath Diameter (ONSD) [4]. ONSD has been established to be a strong predictor of increased ICP, with a high sensitivity and specificity in multiple studies and in systematic reviews.

While papilledema observed by funduscopy may take some time to progress, dilatation of the optic nerve sheath occurs much earlier and may be a near instantaneous sign of increased ICP.

Early diagnosis and rapid treatment of raised ICP is crucial for life saving.

A 1996 research, using ultrasonography studies exposed that ONSD increased by up to 60% at a distance of 3mm behind the globe in comparison to only 35% at 10 mm, that's why a position 3 mm behind the globe is preferred for measurement because this portion reveals the optimum sonographic contrast of the hypoechoic optic nerve complex within the echogenic retrobulbar fat [5].

Modifications in ONSD strongly correlate with imaging findings on cranial Computed Tomography (CT) in patients with increased ICP [6].

## Measuring Optic Nerve Sheath Diameter

Trans-Orbital Optic Nerve Echography (TONE) is used for measuring the Optic Nerve Sheath Diameter (ONSD). TONE is



**Figure 1:** Sagittal plane scan of optic nerve sheath



**Figure 2:** Transverse plane scan of optic nerve sheath

performed by an ultrasound device in B-mode, equipped with a 10 MHz linear probe.

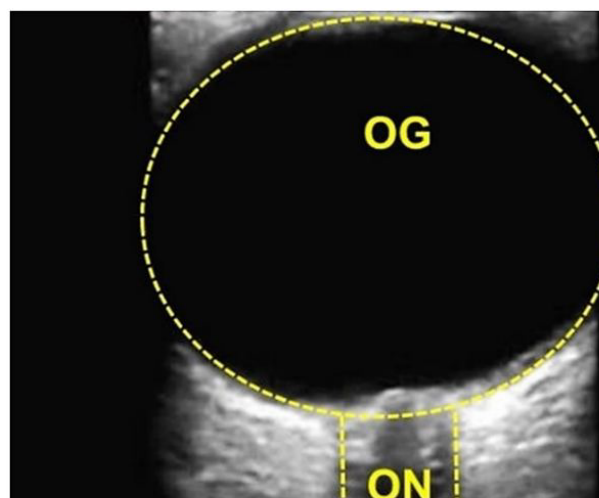
**Patient position:** Patients are placed in a supine position at 20° to the horizontal.

**Exploration.** The probe is placed slightly over the temporal area of closed upper eyelid with a thick ultrasound gel to prevent pressure on the eye. Both the sagittal (Figure 1) and transverse (Figure 2) planes are explored in each eye.

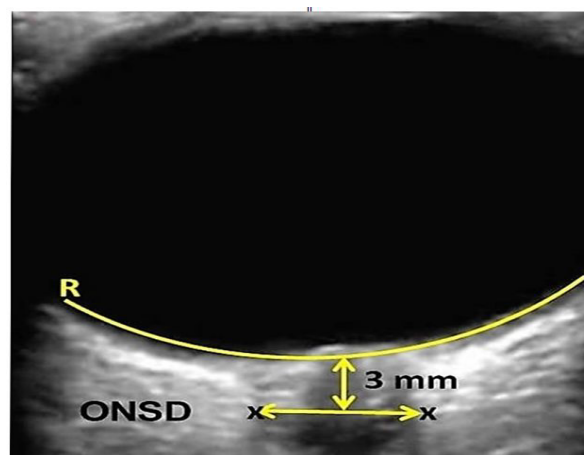
The placement of the probe is adjusted to give a suitable angle for displaying the entry of the optic nerve into the globe. The field must be preset to a depth of 4 cm. The ocular globe and optic nerve are easily visualized (Figure 3).

The image must be frozen; ONSD is measured 3 mm behind the globe, using an electronic caliper and an axis perpendicular to the optic nerve, corresponding to the distance between the two external parts of the optic nerve sheath [7]. ONSD is the horizontal distance between the 2 cursors (Figure 4).

The time spent for performing an ONSD measurement is about 2 minutes [8]. **Interpreting results.** The measures of the sagittal and the transverse ONSD planes must be similar in both eyes. Normal ONSD values are 5 mm. Values over 5.9 mm are consistent with high intracranial pressure [9].



**Figure 3:** Optic nerve sheath ultrasound Legend: OG: Ocular Globe; ON: Optic Nerve



**Figure 4:** Optic nerve sheath ultrasound measures Legend: R: Retina; ONSD: Optic Nerve Sheath Diameter

Finally, an introductory course that includes the opportunity to perform 10 practice examinations followed by 25 supervised studies performed in the clinical setting is a reasonable requirement for learning and performing ONSD measuring [10]. Measuring ONSD using ultrasonography makes available a highly practical method to determine ICP. Being noninvasive, ONSD ultrasonography provides a useful tool in clinical settings for rapid identification of ICP.

## Conclusion

Measurement of optic nerve sheath is a non-invasive, safe, point-of-care, rapid and effective tool for determining high intracranial pressure

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